first end thereby defining a plurality of axially extending arms. A plurality of joints, circumferentially disposed with respect to the carrier and each pivotable about a radial axis, connects at least some of the torque frame arms to the carrier. Under operational load, each joint exerts an individual reaction force on the carrier. Preferably, the joints are positioned so that the resultant reaction force associated with these individual reaction forces is axially coincident with the resultant driving force that rotates the carrier. The torque frame also has a second end near which a connection is made to a rotating component, which in the exemplary embodiment is part of a rotating structure for conveying torque and rotary motion to a fan. In an alternative arrangement, the second end of the torque frame is connected to a mechanical ground that prevents rotation of the torque frame and, therefore, of the carrier.

Rotary motion of the bladed propulsor is resisted by aerodynamic forces acting at finite distances from a central axis thereby creating a torque load which torsionally deflects the torque frame. The torsional deflection manifests itself as bending of the arms at the first end of the torque frame. The pivotability of the joints connecting the torque frame arms to the carrier prevents the bending of the arms from transmitting any torsional deflection into the carrier. Instead, the carrier experiences only essentially tangentially directed reaction forces at each joint location. By locating the joints so that their resultant reaction force is axially coincident with the resultant force that rotates the carrier, the carrier is also isolated from the twisting effect that would result if the driving force and reaction force were axially separated.

In an alternative arrangement and operational mode of the planetary gear train, the planet carrier is held stationary and the ring gear assembly is connected to a load to be driven. In this mode, as in all other alternative modes, the same pivotable joint configuration connects the carrier to the torque frame near its first end. The second end of the torque frame is connected to a nonrotating support structure suitable for precluding rotary motion of the carrier; the carrier reacts the torque being conveyed through the rotating components of the gear train rather than participating in the conveyance.

In other possible arrangements and operational modes, none of the gear assemblies is stationary. One of the assemblies is adapted to accept a rotary input while both of the remaining assemblies are rotary outputs. Use of the pivotable joint as described herein for connecting the planet carrier to the torque frame benefits these single input, dual output configurations as well.

In one embodiment, the pivotable joint is a spherical bearing allowing pivotable motion about a radial axis. In another embodiment, the joint is a radially oriented trunnion connecting the torque frame to the planet carrier. Other pivotable connections would be equally suitable.

The efficacy of the invention is independent of other details of the planetary gear train such as the type of gears and the type of bearing arrangement used to support the planet gears in the carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic cross-sectional elevation of a high bypass aircraft engine employing the geared drive system of the present invention;

FIG. **2** is an enlarged cross-sectional elevation of the geared drive system employed in FIG. **1**;

FIG. **3** is a simplified schematic perspective view of a prior art geared drive system with selected elements removed for clarity;

FIG. **4** is a fragmentary cross-sectional elevation of one embodiment of a joint employed in the geared drive system of the present invention;

FIG. **5** is a partially sectioned perspective view of an alternative embodiment of a joint employed in the geared drive system of the present invention;

FIG. **6** is a simplified perspective view of a planet carrier of the geared drive system of the present invention showing various forces acting on the carrier; and

FIG. **7** is a view similar to FIG. **6** but showing a different force arrangement that preserves the benefits of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The best mode for carrying out the invention is set forth in the context of a high bypass gas turbine aircraft engine shown schematically in FIG. **1**. The engine includes a powerplant **2**, a bladed propulsor or fan **4**, and a drive system **6** for conveying rotary motion from the powerplant to the fan. In this exemplary embodiment, the drive system is a geared drive system including a planetary gear train **8** and a torque transfer structure or torque frame **10**.

The power plant includes axial flow compressors **12** and **13** rotating about a longitudinally extending central axis **14** to compress intake air **3** and deliver it to a combustor **16** to be mixed with fuel (not shown) and ignited. Axial flow turbine **18** extracts energy from the hot combustion gases and, by means of shaft **21** drives compressor **13**. Similarly, turbine **19** drives compressor **12** by means of shaft **20**. Fan **4** is also driven by turbine **19**, however, a planetary gear train **8** and a torque frame **10** are located mechanically intermediate the shaft **20** and the fan **4**. The fan imparts a modest acceleration to a large volume of air, thereby producing substantial forward thrust. Any energy not consumed in the turbine to drive the fan and compressor is converted to addition forward thrust in the exhaust nozzle **22**.

Referring to FIGS. **1** and **2**, in the planetary gear train **8**, a sun gear **24** is rotatably driven by the shaft **20**. A ring gear **26** is fixed to the engine static structure and remains stationary relative to the rotating sun gear. A plurality of planet gears **28** is rotatably mounted in a planet carrier **30** so that each planet gear is in meshing engagement with the sun gear and ring gear. The sun gear, planet carrier and ring gear share the common central axis **14** while the planet gears have individual axes of rotation **32**. In the illustrated embodiment, the sun gear and planet carrier are rotatable about the central axis while the ring gear is fixed relative thereto. Preferably, the gears are bihelical, as illustrated in FIGS. **1** and **2**, ensure smooth meshing and quiet operation, however, the invention is independent of the type of gears used, and simple spur gears are depicted in the other Figures to ensure clarity of the disclosure.

The geared drive system of FIG. **1** is illustrated in more detail in FIG. **2**. A sun gear assembly **50** includes the forward portion **19** of the shaft **20** and the sun gear **24**. A stationary ring gear assembly **52** includes the ring gear **26** and a nonrotating support structure **54** which may be the engine case or a mounting arrangement connecting the ring gear to the engine case. A planet gear assembly **56** includes the plurality of planet gears **28**, a carrier **30** having a forward end plate **31** and a rear end plate **33**, and planet gear journals